Trace Elements in Lake Roosevelt Sediments and Air

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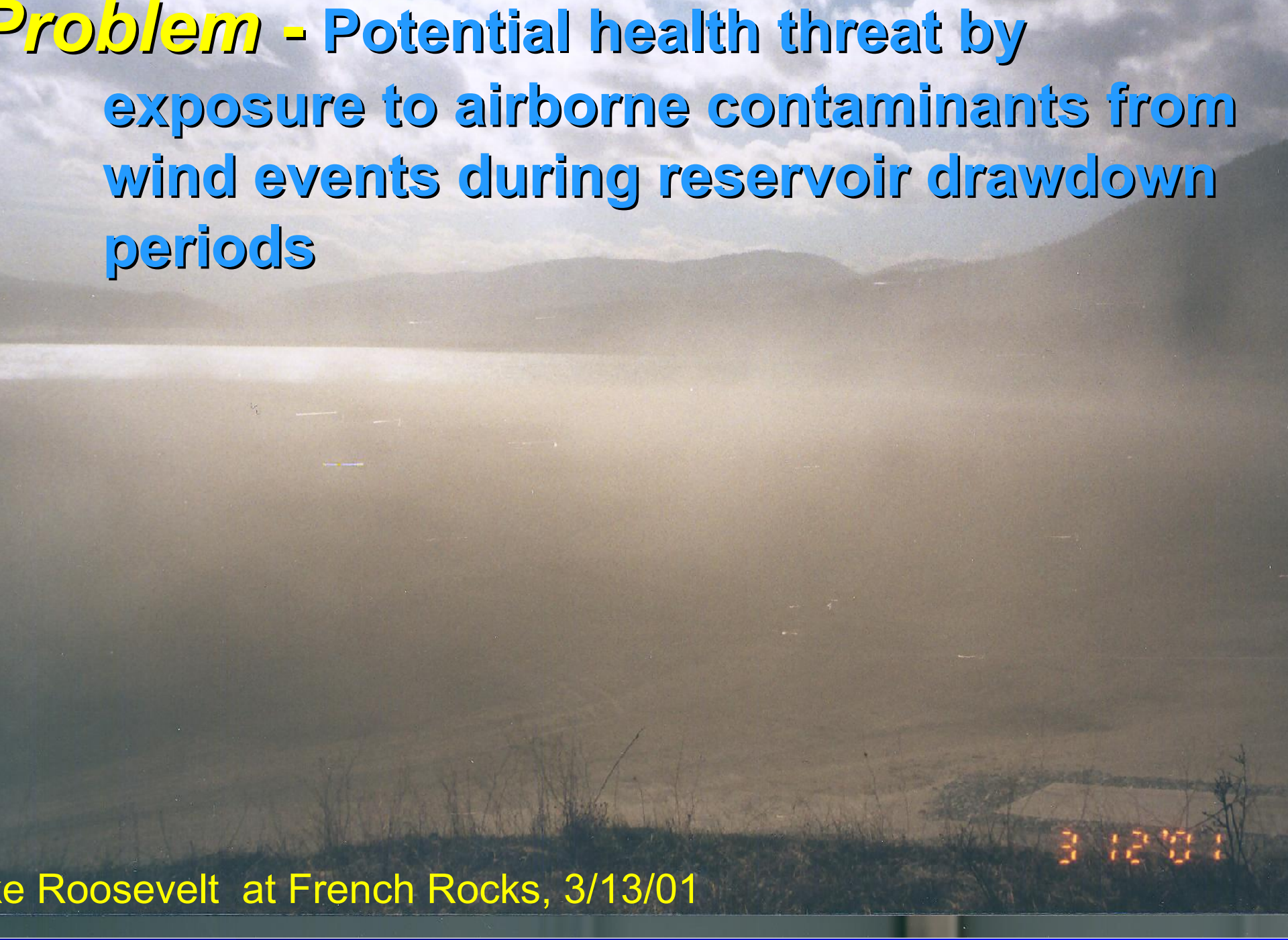
U.S. Geological Survey

in cooperation with

The Water Quality Council of the Confederated Tribes of the Colville Indian Reservation and the U.S. Bureau of Reclamation

08 April 2003


Problem - Potential health threat by exposure to airborne contaminants from wind events during reservoir drawdown periods
3 12 01
e Roosevelt at French Rocks, 3/13/01

Objectives

- **Part I**
  - Determine the concentrations of trace elements in the fine-grained fraction of exposed beach, bed, and bank sediments from Grand Coulee Dam to the Canadian border

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- **Part I**
  - Determine the concentrations of trace elements in the fine-grained fraction of exposed beach, bed, and bank sediments from Grand Coulee Dam to the Canadian border
- **Part II**
  - Determine concentrations of trace elements in airborne dust during ambient and dust-event conditions
  - Determine if exposed beach and bed sediments are the source of the airborne trace elements

Approach - Part I

- Two different, but complementary, sampling designs
  - Targeted sampling (6 sites)
    - Large exposures of fine- grained deposits close to downwind communities and recreational areas
  - Spatially Distributed sampling (18 sites)
    - Major depositional zones to assess the overall spatial distribution of sediment associated trace elements from Grand Coulee Dam to the Canadian border

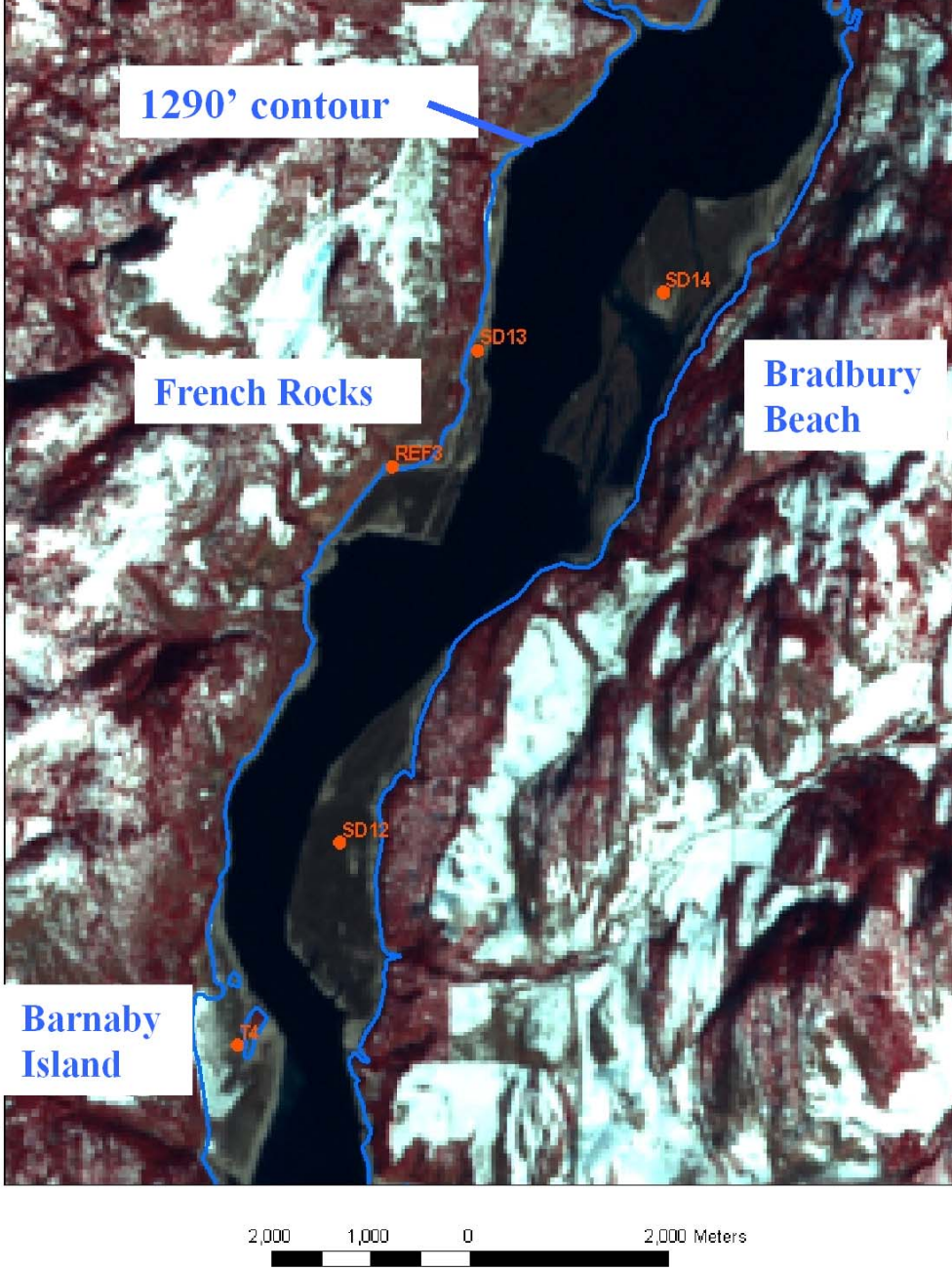
Approach

6 Target sites

- ID during pre-sampling reconnaissance, March 2001

18 Spatially Distributed sites

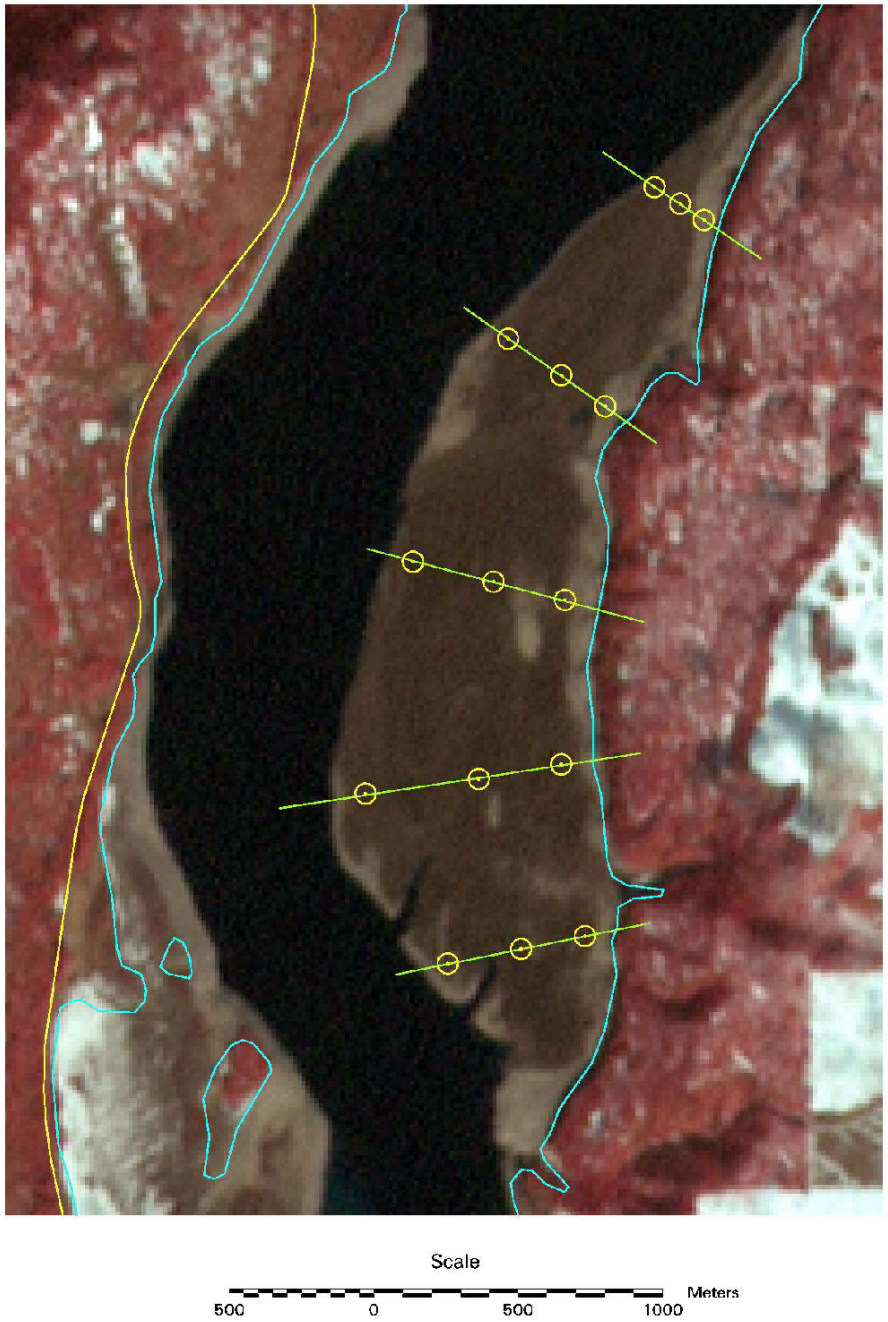
- determined using March 6, 2001 LANDSAT-7 Images. Enabled the identification of major areas of exposed sediment.



Approach

Sample locations and coordinates were determined from LANDSAT images

Sediment from 15 locations were composited into one sample



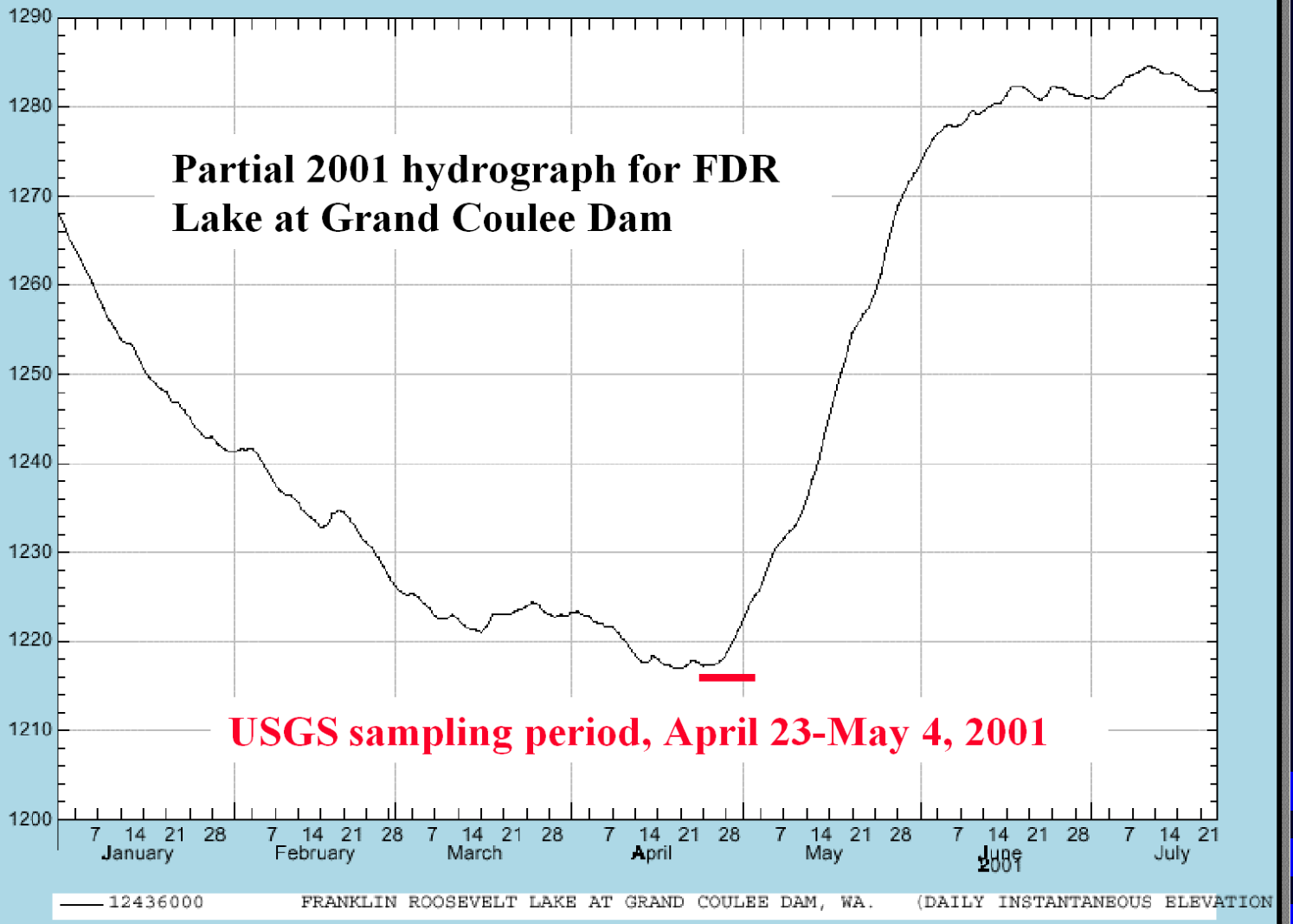
Approach

- **Reference Samples (5 sites)**
  - Upstream locations from Trail, BC (Lower Arrow Lake, 2 sites)
  - Glacial sediments above high water along Lake Roosevelt (3 sites)

- **'Riverine Slag' sample (1 site)**
  - Sediment from riverine environment north of US-CA border


CANADA
WASHINGTON
IDAHO
REF2
REF1
Trail
SLAG
Kettle R.
Columbia River
SD18
Northport
SD17
SD16
T6
T5
Kettle Falls
SD15
Colville
SD14
REF3
SD13
T4
SD12
SD11
Colville Indian Reservation
Pend Oreille River
Priest Lake
SD9
SD10
REF4
Sanpoil R.
SD8
Roosevelt Lake
T3
SD7
SD6
SD5
SD1
T1
SD3
SD2
SD4
T2
REF5
Spokane Indian Reservation
Little Spokane River
Spokane River
Spokane

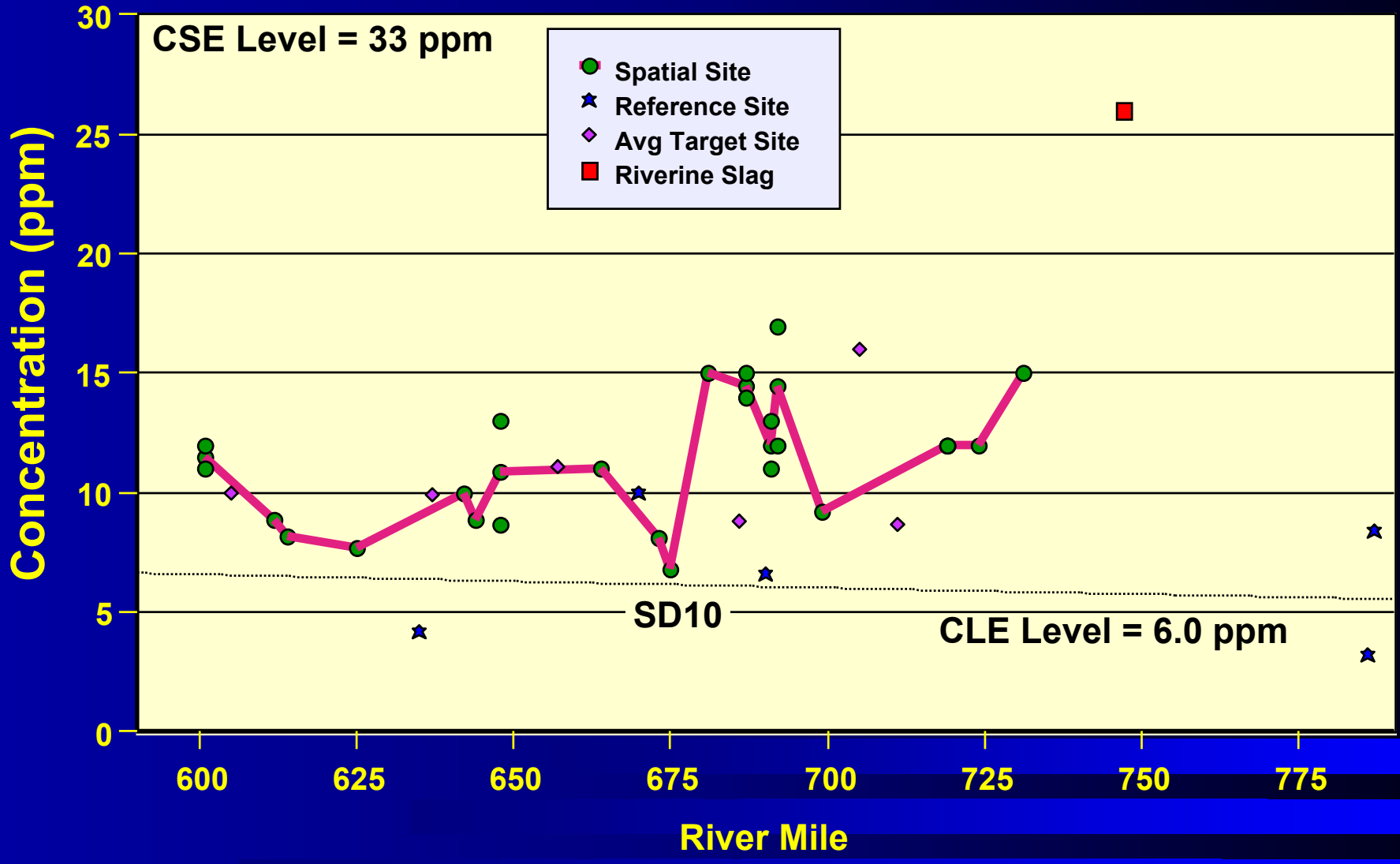
Sediment Collection



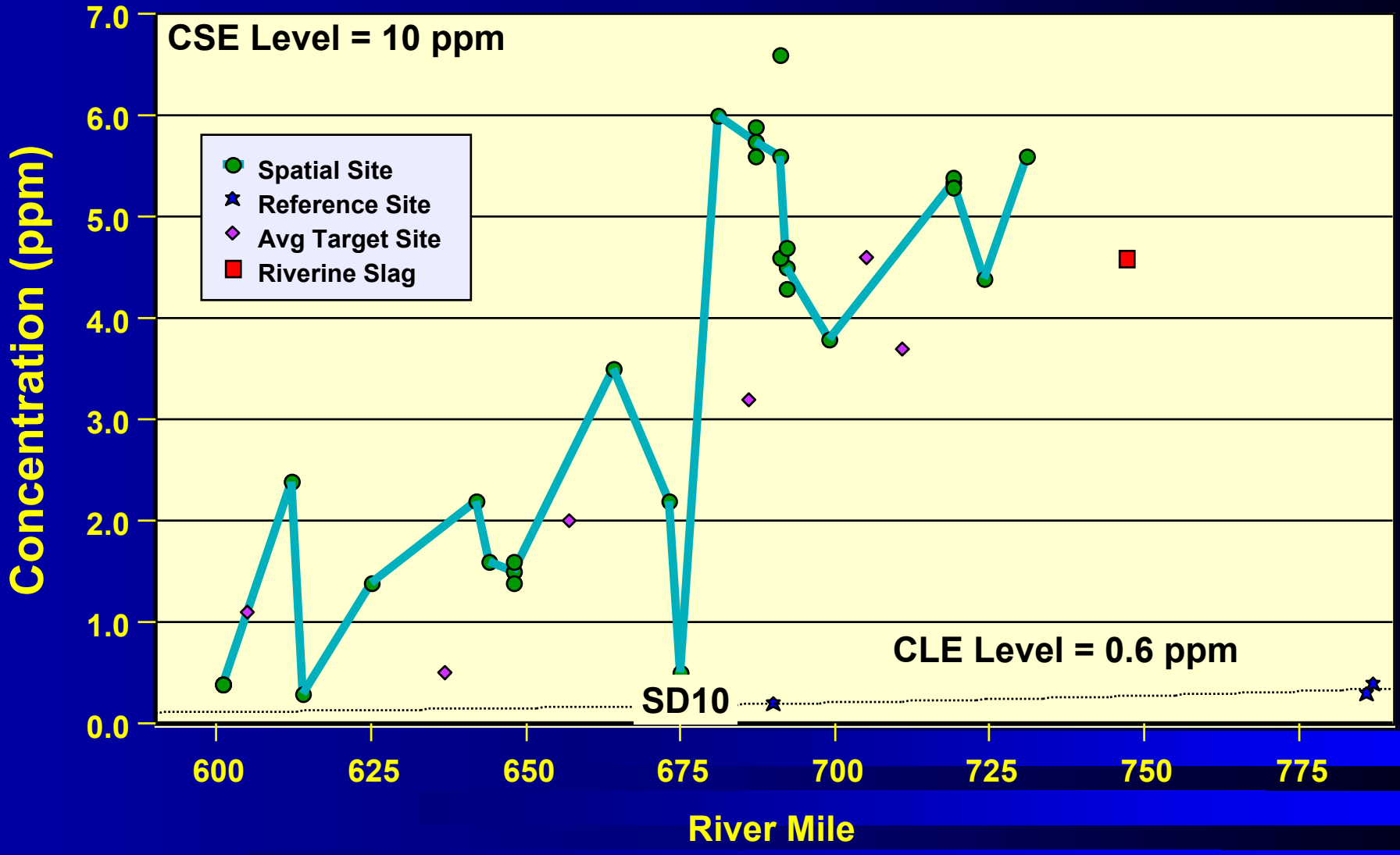
Analysis

Ag, silver	Cu, copper	Pb, lead
Al, aluminum	Fe, iron	Rb, rubidium
As, arsenic	Ga, gallium	Sb, antimony
Ba, barium	K, potassium	Se, selenium
Be, beryllium	La, lanthanum	Sr, strontium
Bi, bismuth	Li, lithium	Th, thorium
Ca, calcium	Mg, magnesium	Ti, titanium
Cd, cadmium	Mn, manganese	Tl, thallium
Ce, cerium	Mo, molybdenum	U, uranium
Co, cobalt	Na, sodium	V, vanadium
Cr, chromium	Ni, nickel	Y, yttrium
Cs, cesium	P, phosphorus	Zn, zinc

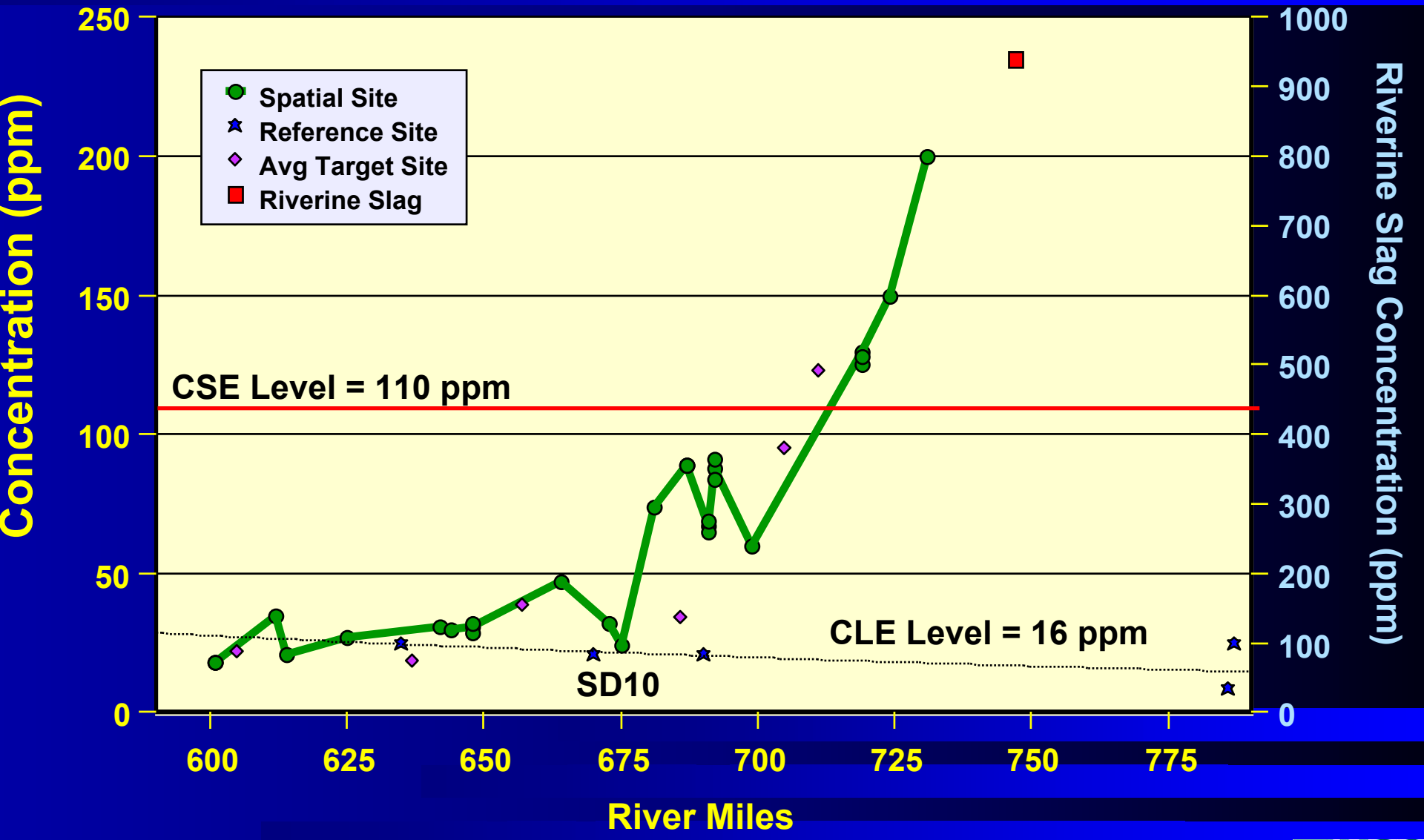
Arsenic


CSE Level = 33 ppm
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
Concentration (ppm)
30
25
20
15
10
5
0
SD10
CLE Level = 6.0 ppm
600
625
650
675
700
725
750
775
River Mile

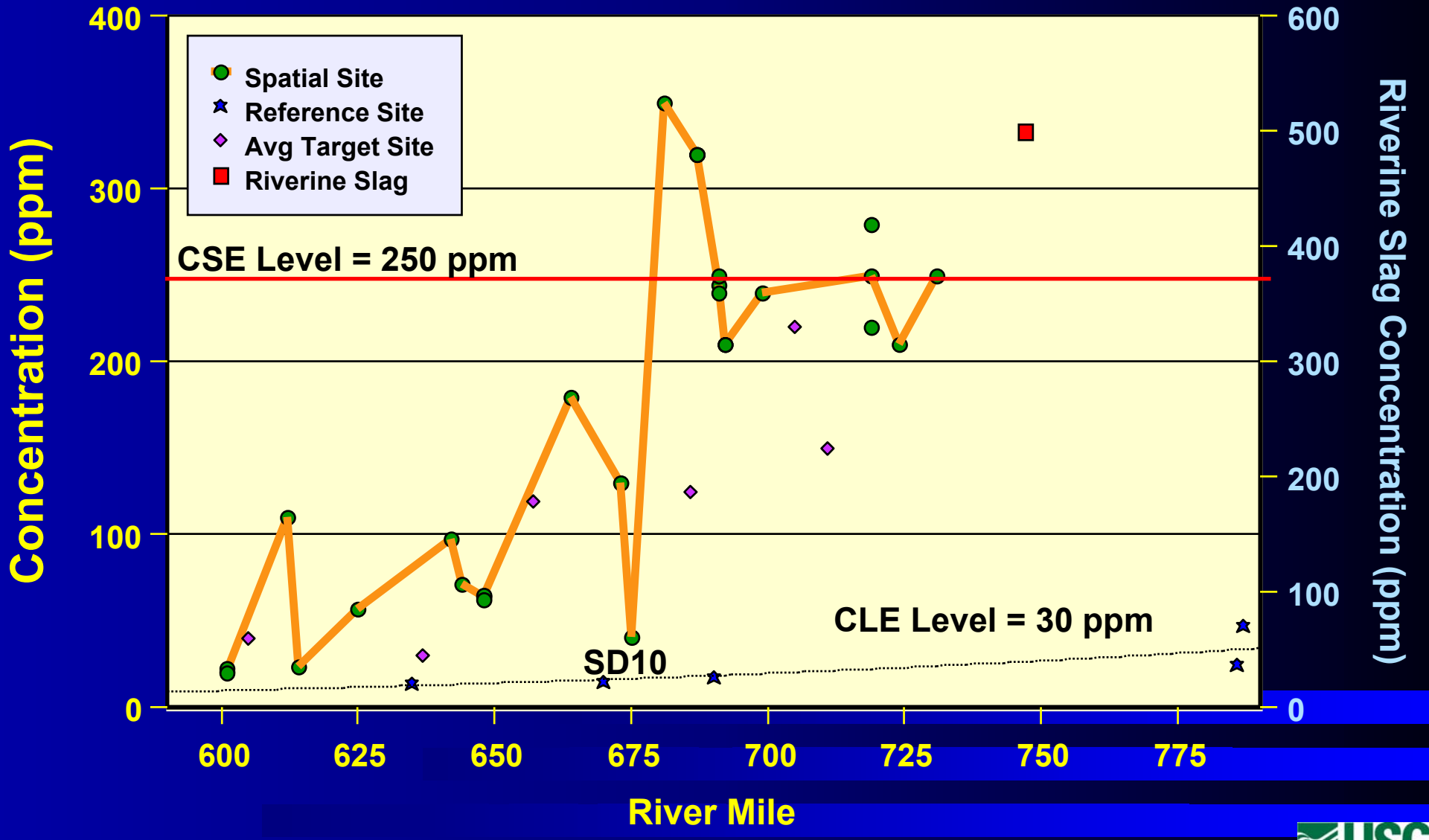
Cadmium


CSE Level = 10 ppm
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
CLE Level = 0.6 ppm
SD10
Concentration (ppm)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
600
625
650
675
700
725
750
775
River Mile

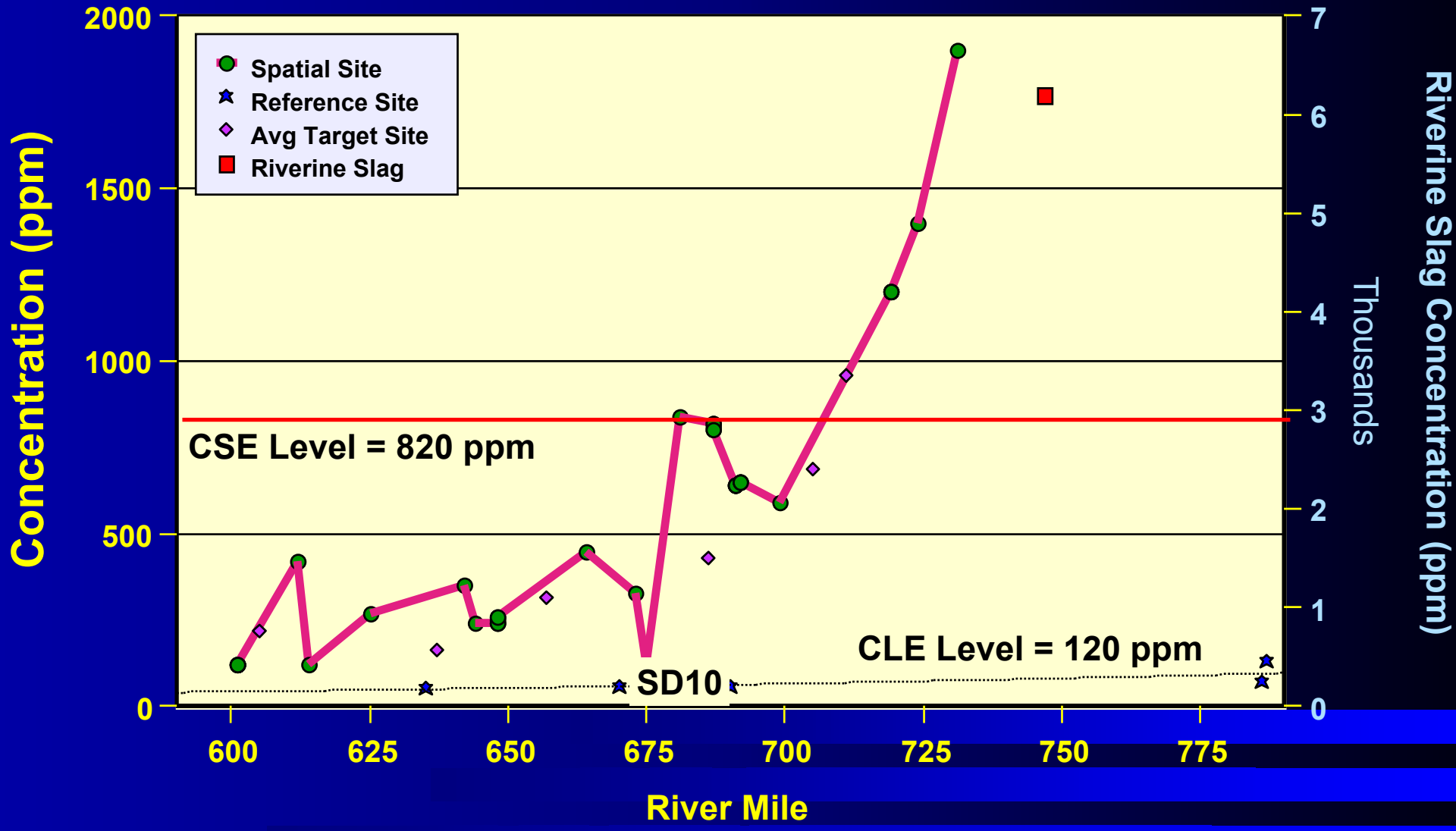
Copper


Concentration (ppm)
Riverine Slag Concentration (ppm)
River Miles
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
CSE Level = 110 ppm
CLE Level = 16 ppm
SD10
250
200
150
100
50
0
1000
900
800
700
600
500
400
300
200
100
0
600
625
650
675
700
725
750
775

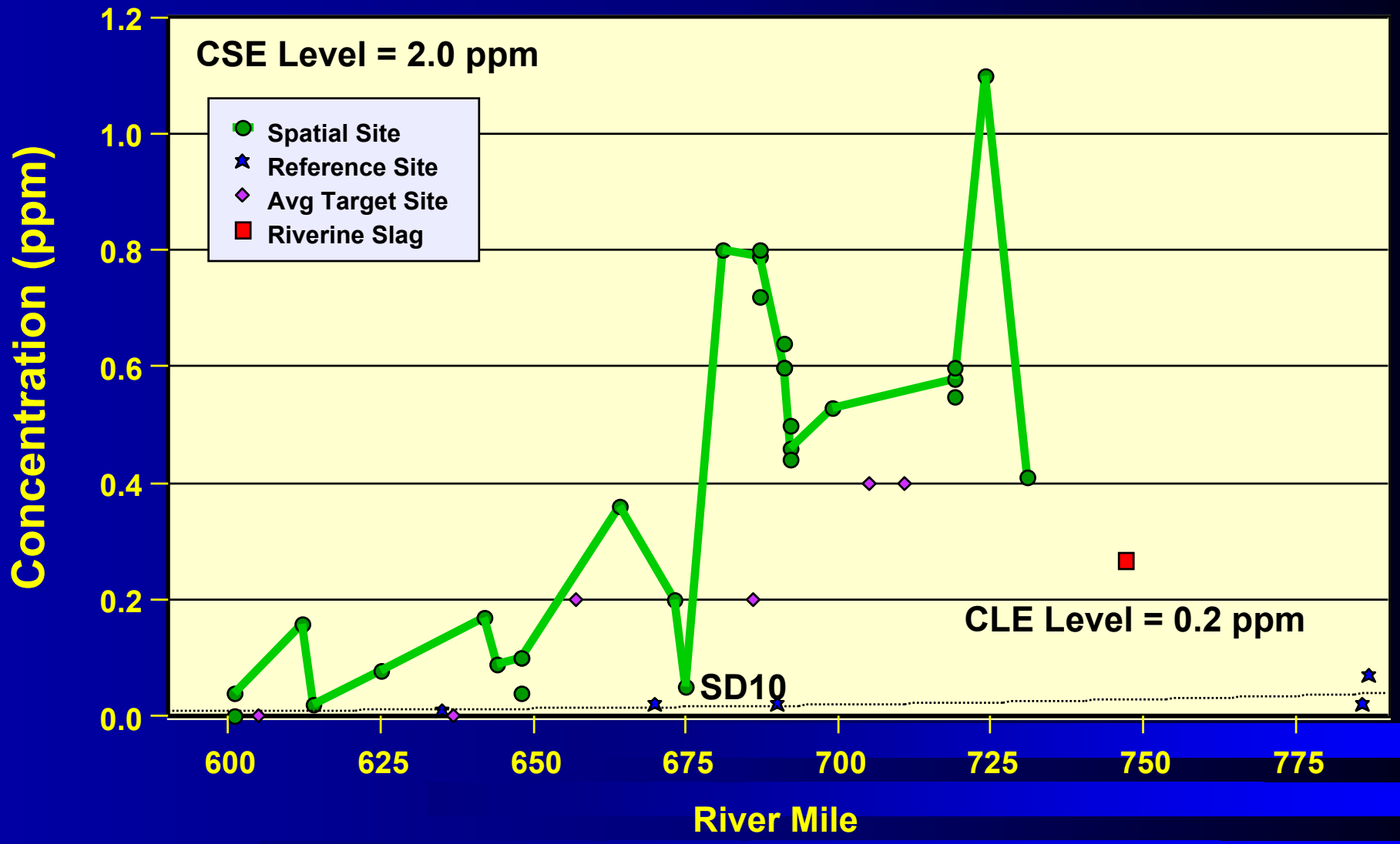
Lead


Spatial Site
Reference Site
Avg Target Site
Riverine Slag
CSE Level = 250 ppm
CLE Level = 30 ppm
SD10
Concentration (ppm)
Riverine Slag Concentration (ppm)
River Mile
0
100
200
300
400
500
600
600
625
650
675
700
725
750
775

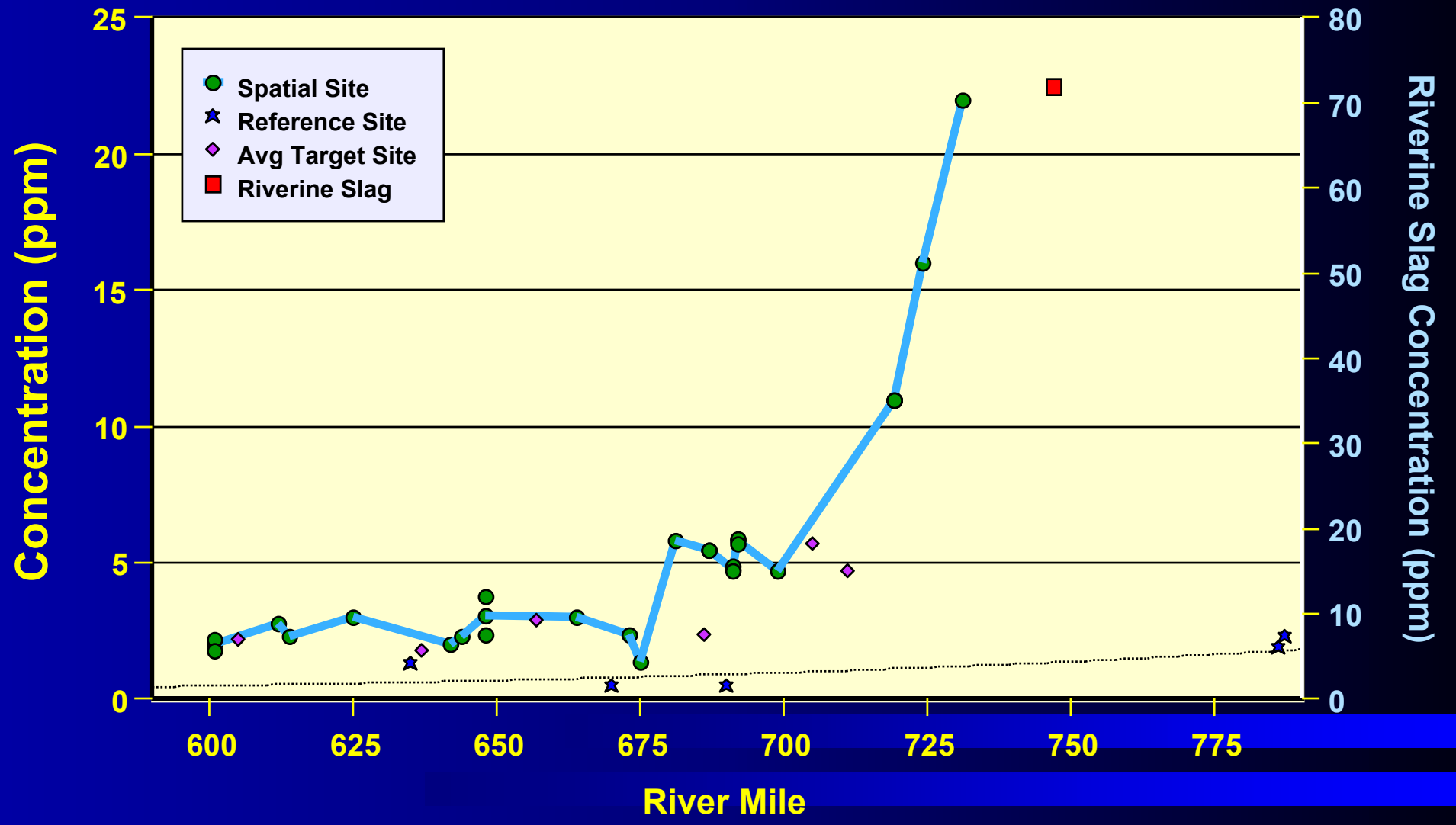
Zinc


Concentration (ppm)
2000
1500
1000
500
0
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
CSE Level = 820 ppm
CLE Level = 120 ppm
SD10
600
625
650
675
700
725
750
775
River Mile
Riverine Slag Concentration (ppm)
Thousands
7
6
5
4
3
2
1
0

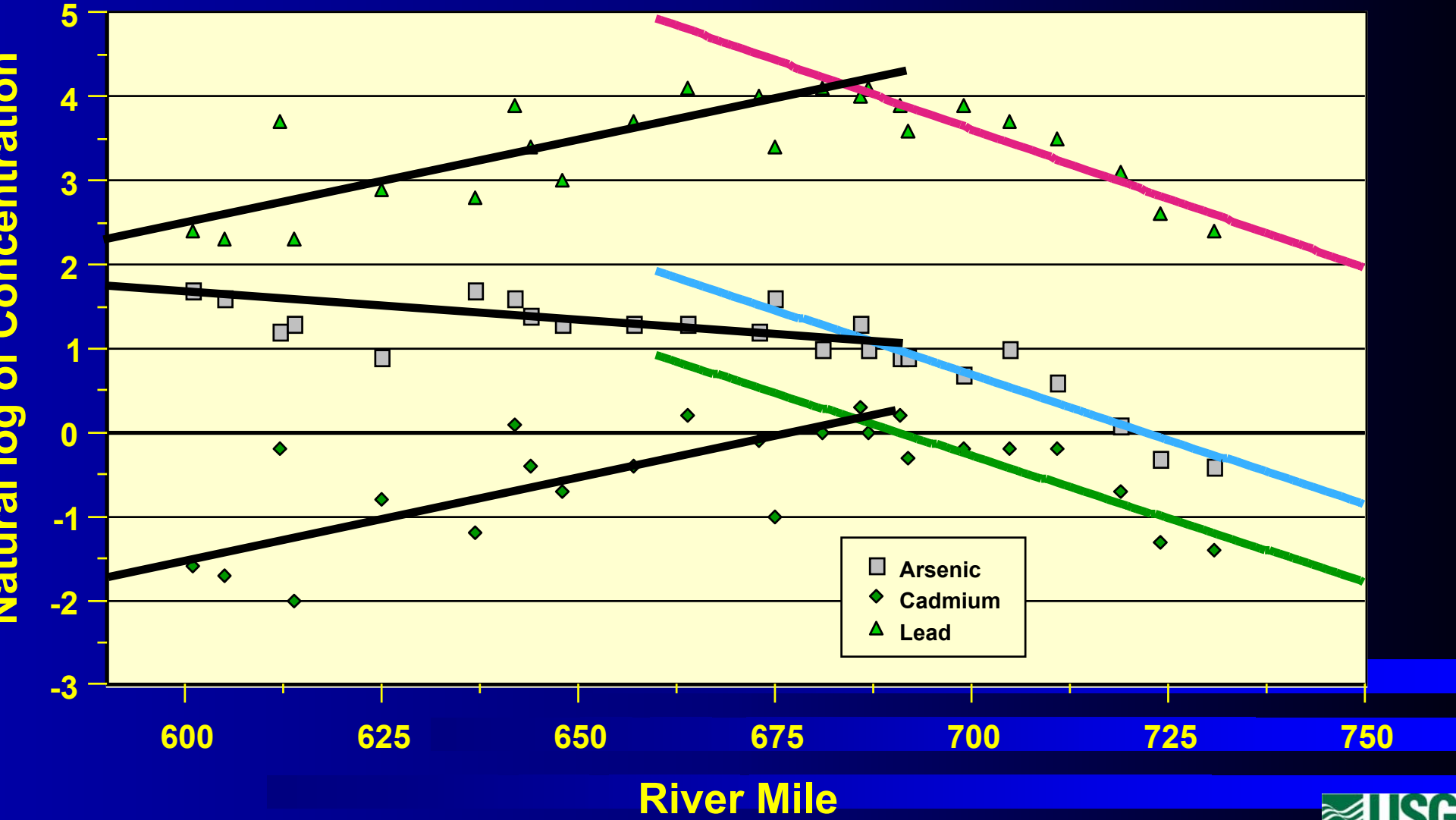
Mercury


CSE Level = 2.0 ppm
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
CLE Level = 0.2 ppm
SD10
Concentration (ppm)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
600
625
650
675
700
725
750
775
River Mile

Tin


Concentration (ppm)
Riverine Slag Concentration (ppm)
River Mile
Spatial Site
Reference Site
Avg Target Site
Riverine Slag
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
600
625
650
675
700
725
750
775

Normalized on Tin Concentration



Part II - Air Sampling

- To coincide with significant Lake drawdown events
  - Winter - January through June
  - Fall - ~September
- PM10 Sampling - EPA Method IO-2.1
  - Every 6th day during season - Coordinated with SCAPCA air sampling program
  - Sampling began in January, 2002
- Dust events

Air Sampling

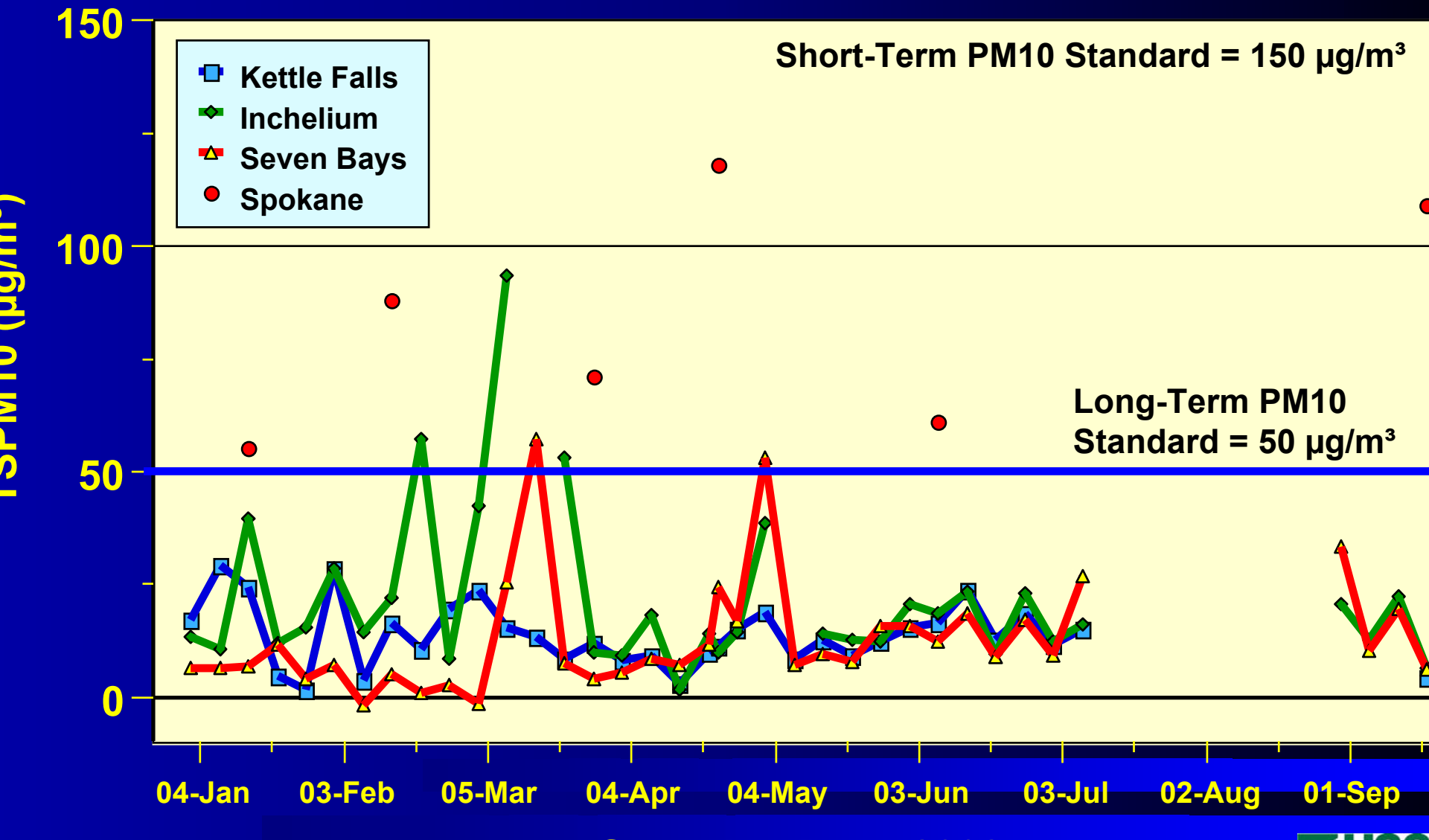
- PM10 High Volume Air Samplers
  - 24 h samples
  - Quartz-fiber Filters
  - Every 6th day
  - High Wind Events
- Meteorological Station at Each Site

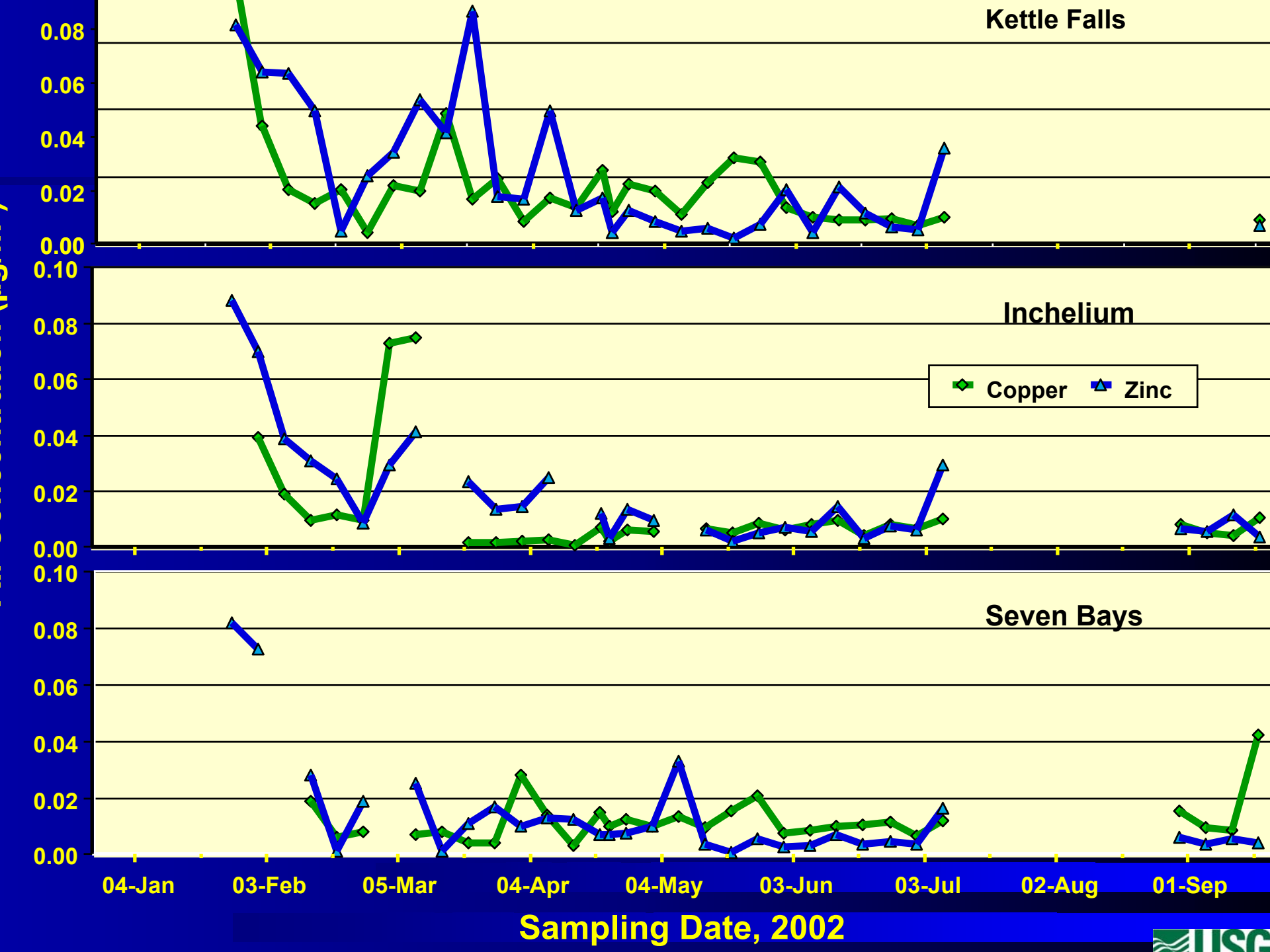
Air Sampling

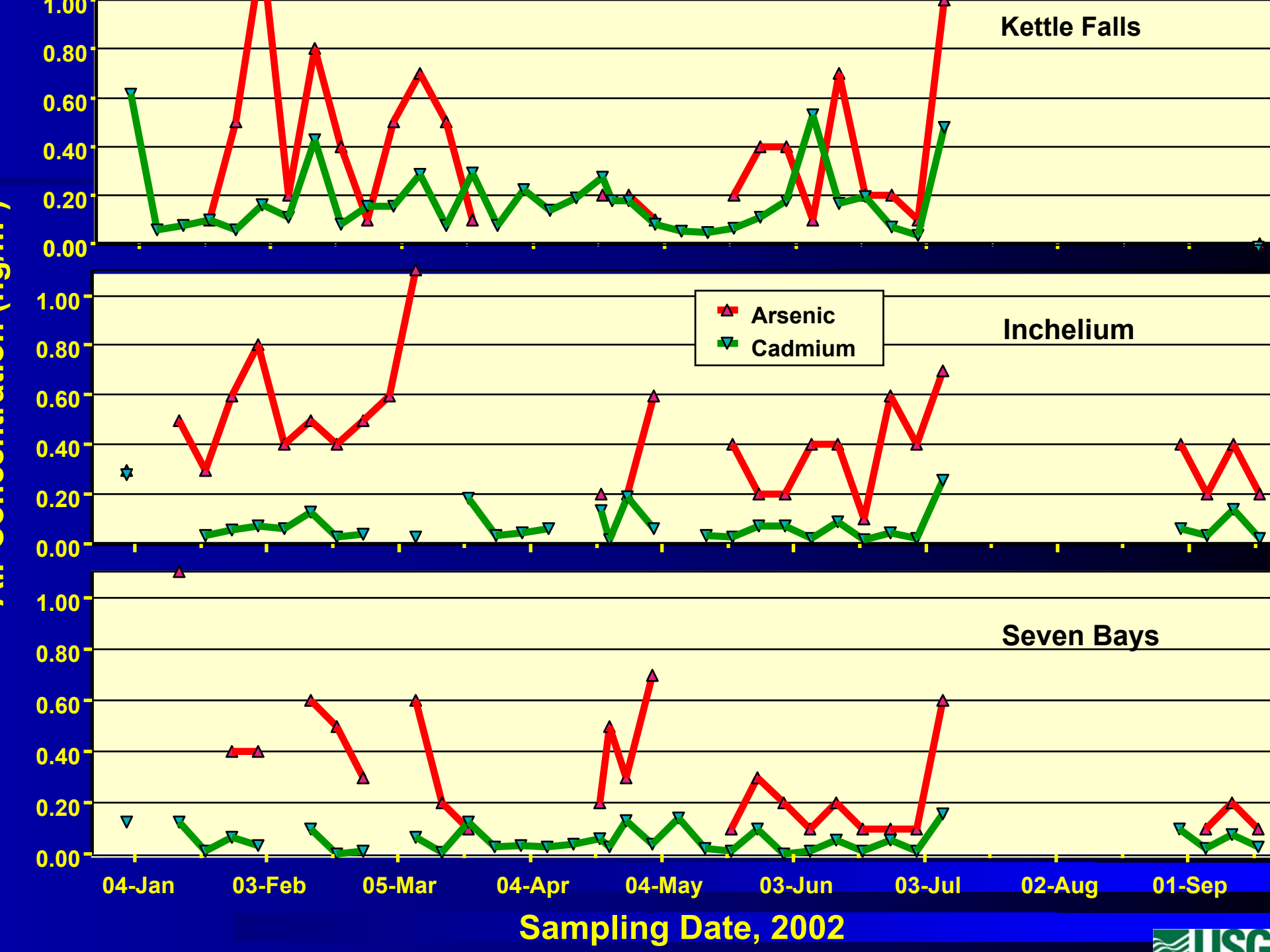
- **Analytical**
  - **42 Trace Elements**
    - Same suite as analyzed for in 2001 bed sediment survey, except mercury
    - Detection Limits
      - 0.0007 to 5 µg or
      - 0.0004 to 3 ng/m^3

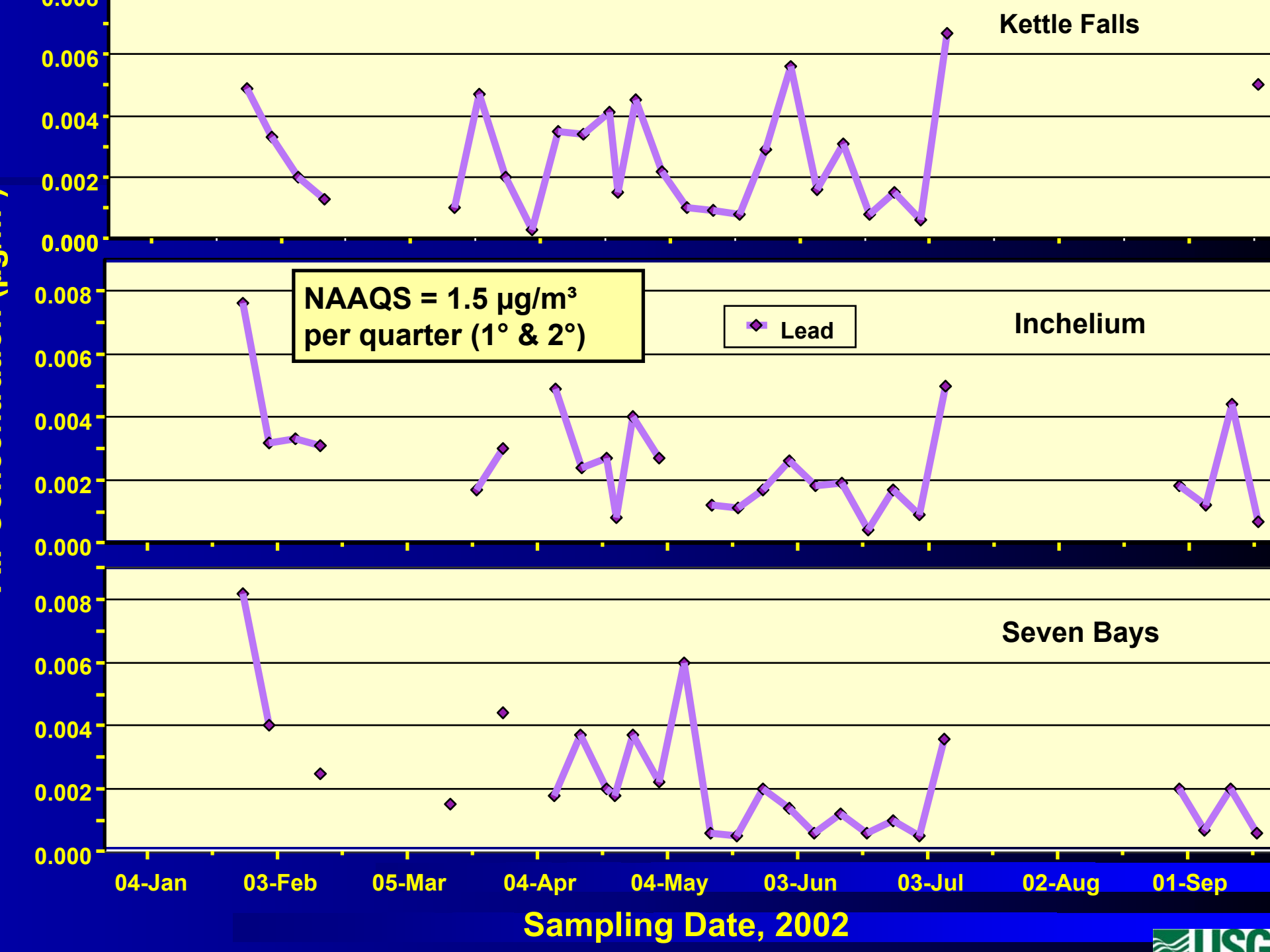

CANADA
WASHINGTON
REF2
REF1
Kettle R.
SD16
T6
T5
SD15
SD14
REF3
SD13
T4
SD12
SD11
SD9
SD10
REF4
SD8
T3
SD7
SD6
SD5
T2
REF5
SD4
SD3
SD2
T1
SD1
Sanpoil R.
Roosevelt Lake
Kettle Falls
Inchelium
Seven-Bays

Total Suspended PM 10




Kettle Falls
Inchelium
Seven Bays
Copper
Zinc
0.00
0.02
0.04
0.06
0.08
0.10
04-Jan
03-Feb
05-Mar
04-Apr
04-May
03-Jun
03-Jul
02-Aug
01-Sep
Sampling Date, 2002


Kettle Falls
Inchelium
Seven Bays
Arsenic
Cadmium
1.00
0.80
0.60
0.40
0.20
0.00
04-Jan
03-Feb
05-Mar
04-Apr
04-May
03-Jun
03-Jul
02-Aug
01-Sep
Sampling Date, 2002


Kettle Falls
Inchelium
Seven Bays
NAAQS = 1.5 µg/m³
per quarter (1° & 2°)
Lead
0.000
0.002
0.004
0.006
0.008
04-Jan
03-Feb
05-Mar
04-Apr
04-May
03-Jun
03-Jul
02-Aug
01-Sep
Sampling Date, 2002

Metals Considered Hazardous Air Pollutants

- Chronic Inhalation Reference Levels

Arsenic	30 ng/m^3
Cadmium	10 ng/m^3
Copper	None
Lead	1.5 µg/m^3
Zinc	None

Summary - Bed Sediments

- **Slag-related trace elements**
  - Concentration gradients exist from International Border to Grand Coolee Dam
  - Areas with concentrations that exceed Canadian Severe Effect Levels as well as the Canadian Lowest Effect Levels for benthic organisms
  - Upper half of lake is most impacted by treated slag discharges

Summary - Air Monitoring

- Air Monitoring program began in 2002
  - Operated from January through June, and September
- TSPM10 concentrations did not exceed the Short-Term Standard of 150 µg/m³
  - Several days did exceed the Long-Term Standard of 50 µg/m³
- Air concentrations of slag related trace elements were low
  - Lake levels in 2002 were not as low as in 2001
  - Number of significant dust events was also low